A variational assimilation ensemble to provide flow-dependent B

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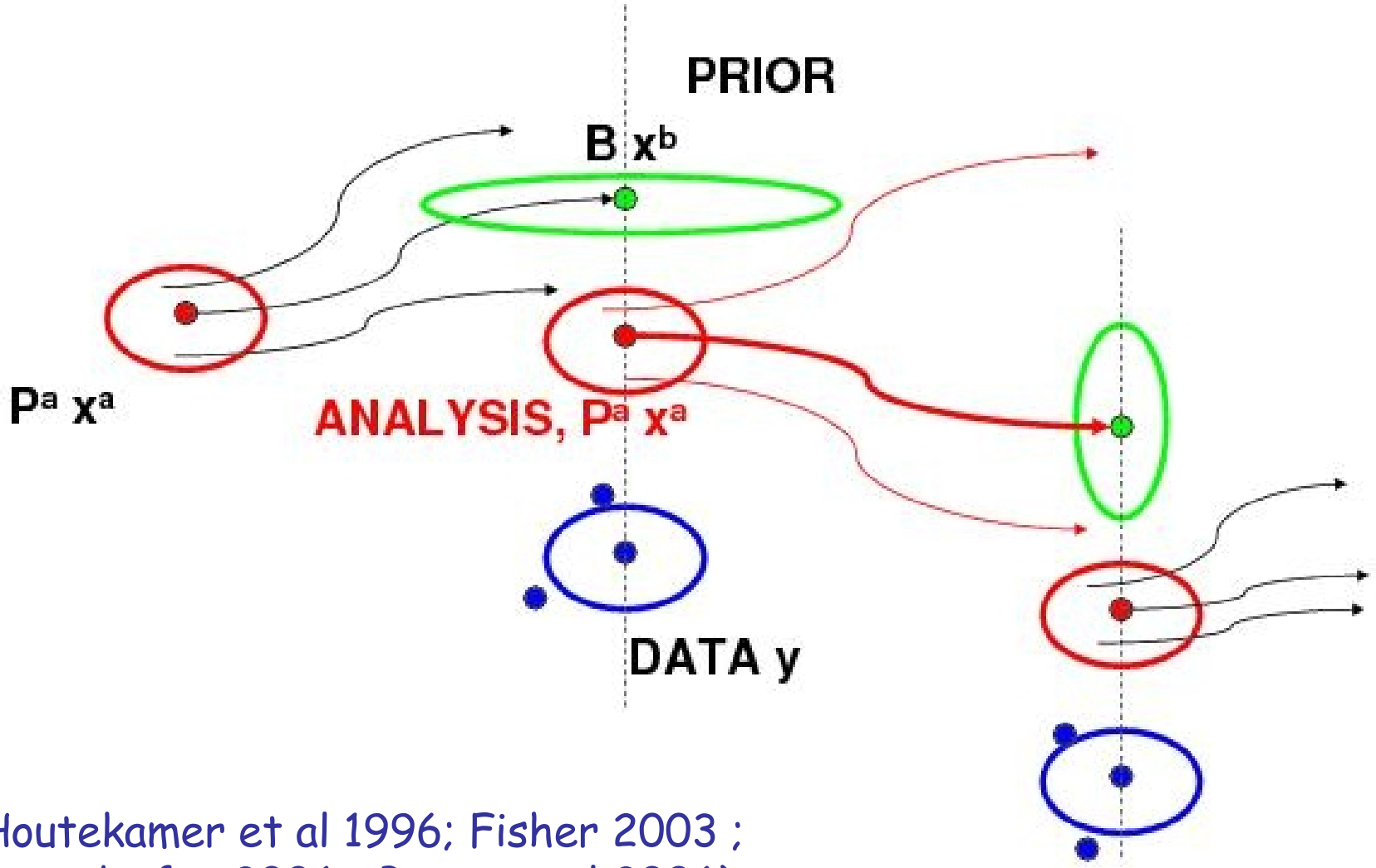
Outlook

- Principle and design of the assimilation ensemble
- Increase of sample size by local spatial averaging
- Applications to represent flow-dependence of B

An ensemble of perturbed assimilations : to simulate the error evolution



(Houtekamer et al 1996; Fisher 2003 ; Ehrendorfer 2006 ; Berre et al 2006)

A real time assimilation ensemble

 global members T359 L60 with 3D-Fgat (Arpège).

patial filtering of error variances,
o further increase the sample size and robustness.

 double suite uses these « σb's of the day » in 4D-Var.
⇒ operational within 2008.

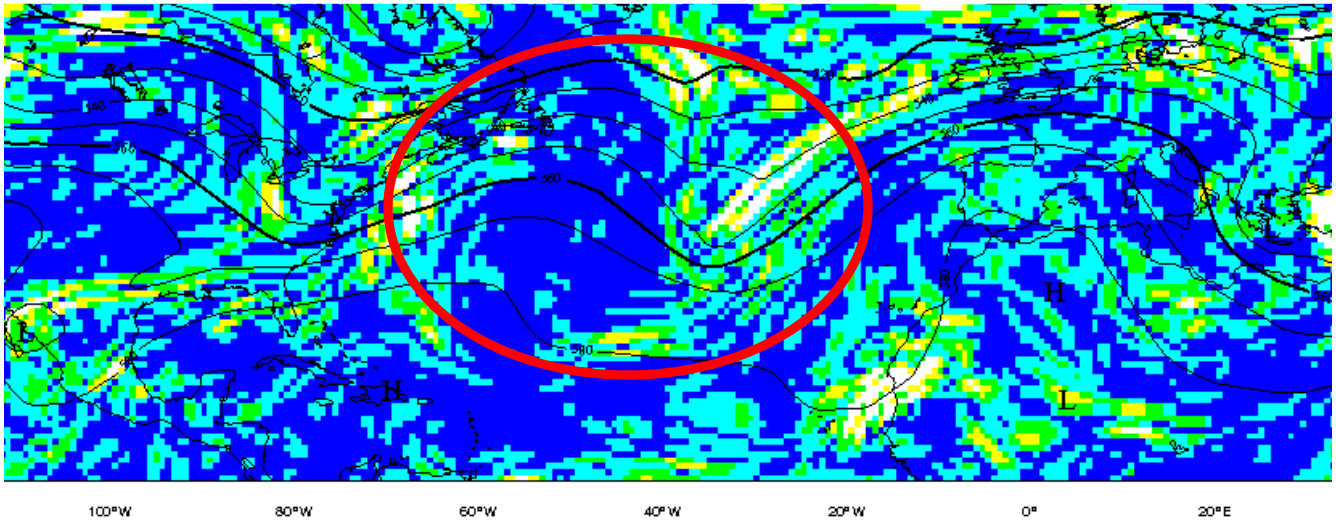
oupling with six LAM members during two seasons of
wo weeks, with both Aladin (10 km) and Arome (2.5 km).

ONE EXAMPLE OF "RAW" σ_b MAPS (Vor, 500 hPa)

FROM TWO INDEPENDENT 3-MEMBER ENSEMBLES

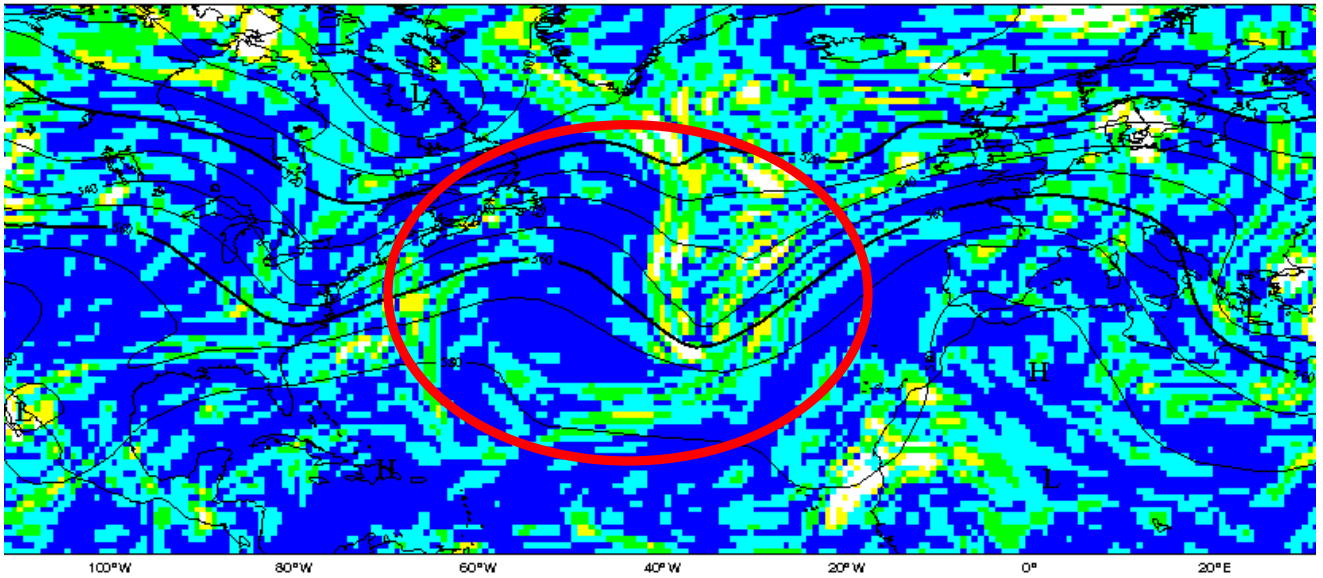
« RAW » σ_b

ENS #1



« RAW » σ_b

ENS #2

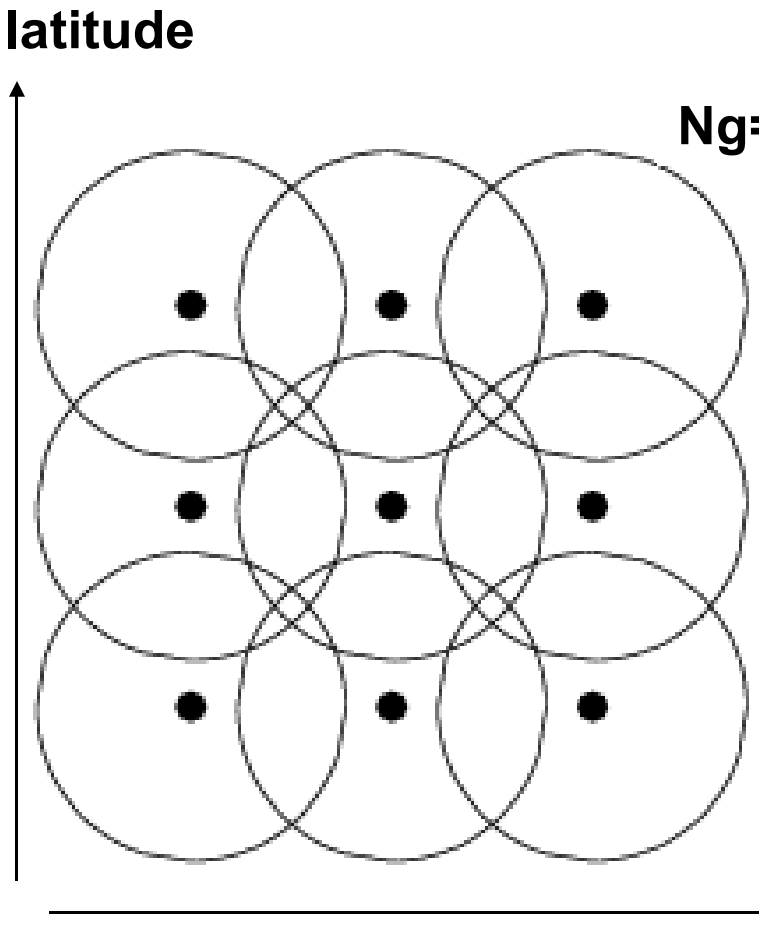


Large scale structures look similar & well connected to the flow !

=>Optimize further the estimation, by accounting for spatial structures (of signal & noise).

INCREASE OF SAMPLE SIZE BY LOCAL SPATIAL AVERAGING: CONCEPT

Idea: MULTIPLY(!) the ensemble size Ne by a number Ng of gridpoint samples.



If Ne=6, then the total sample size is Ne x Ng = 54.

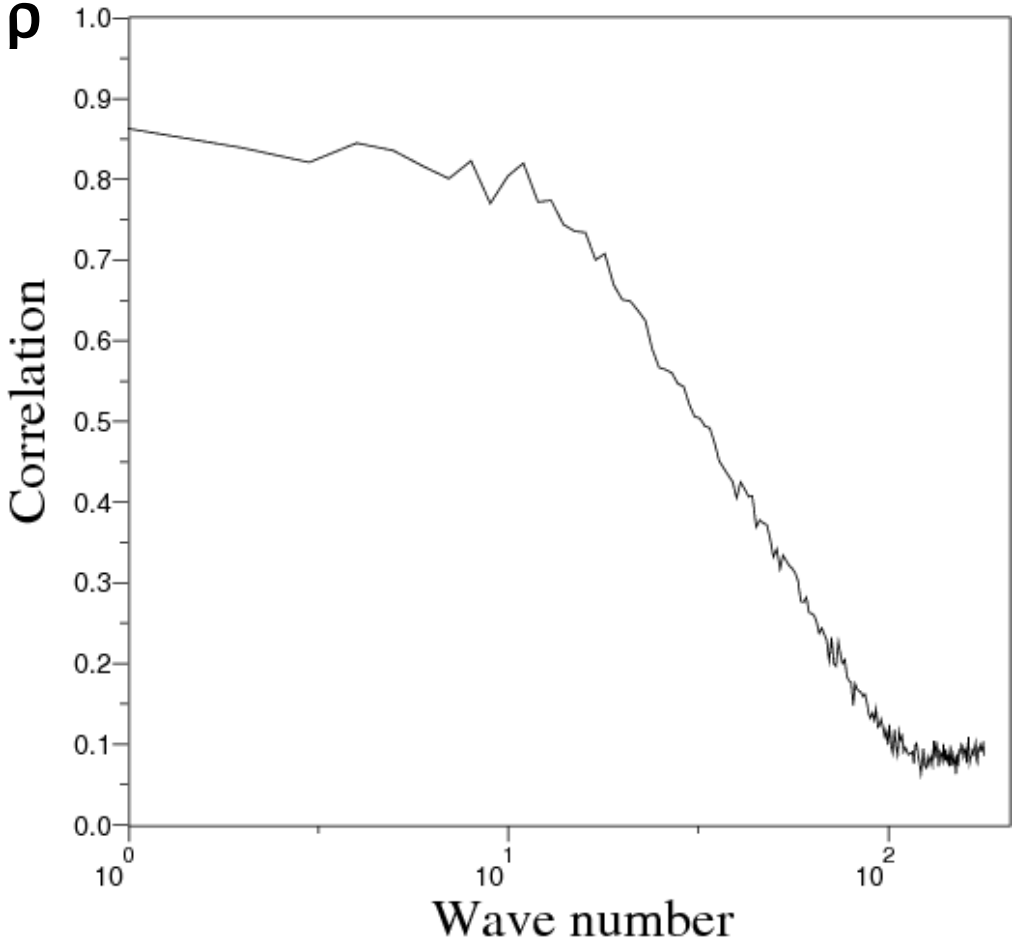
⇒The 6-member filtered estimate is as accurate as a 54-member raw estimate, under a local homogeneity asumption.

INCREASE OF SAMPLE SIZE
BY LOCAL SPATIAL AVERAGING:
OPTIMAL ESTIMATE FORMALISM & IMPLEMENTATION

Apply the classical BLUE optimal equation (as in data assim°),

with a filter ρ accounting for spatial structures of signal and noise:

ρ



$\sigma_b^* \sim \rho\, \sigma_b$

with

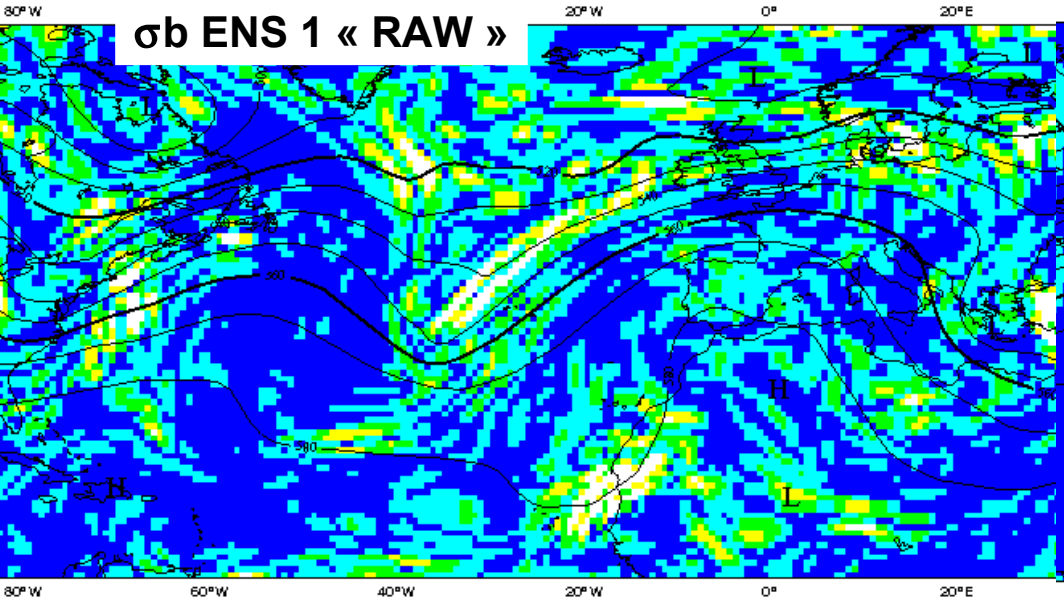
ρ = signal / (signal+noise)

⇒ ρ is a low-pass filter

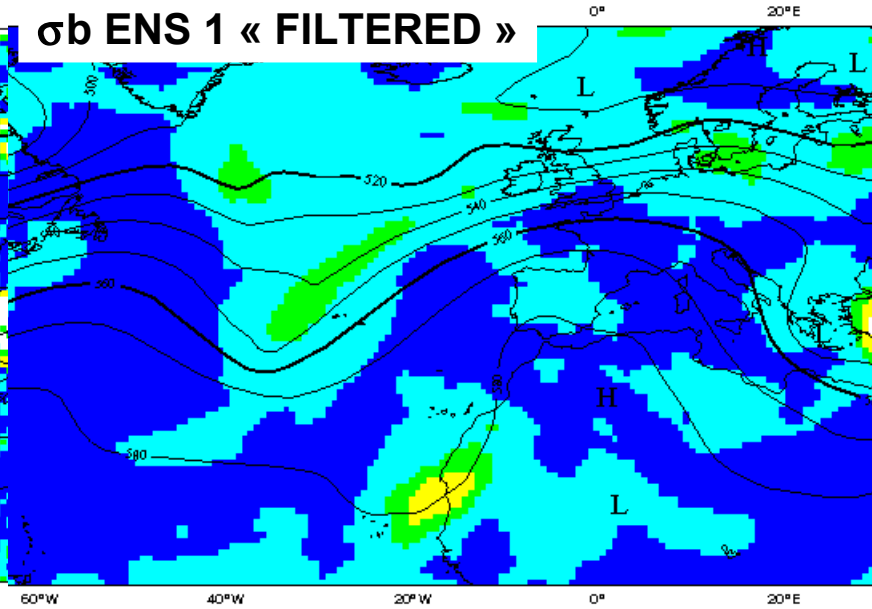
(as K in data assim°).

RESULTS OF THE FILTERING

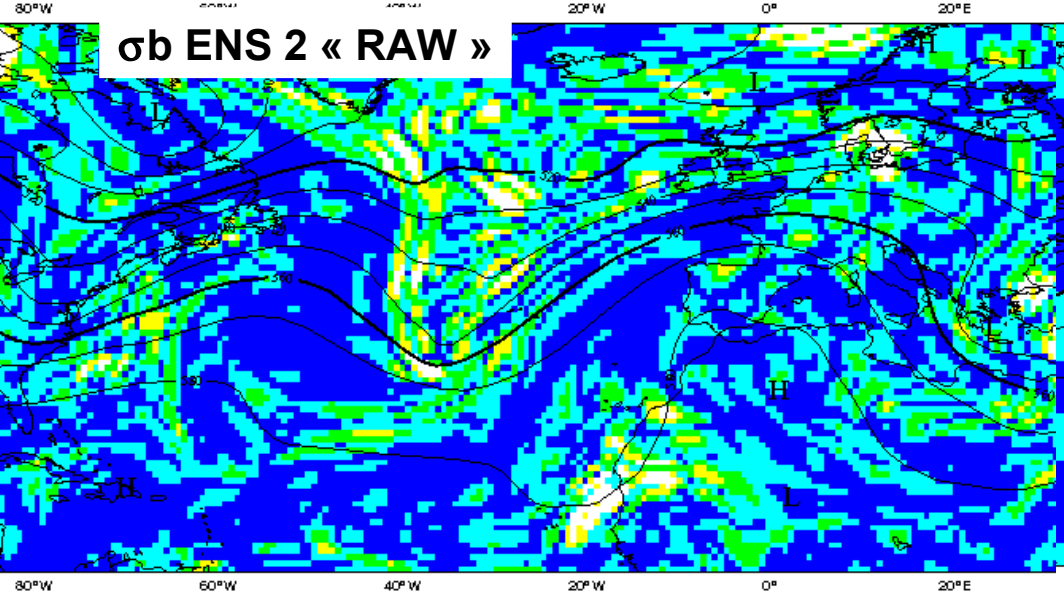
σb ENS 1 « RAW »



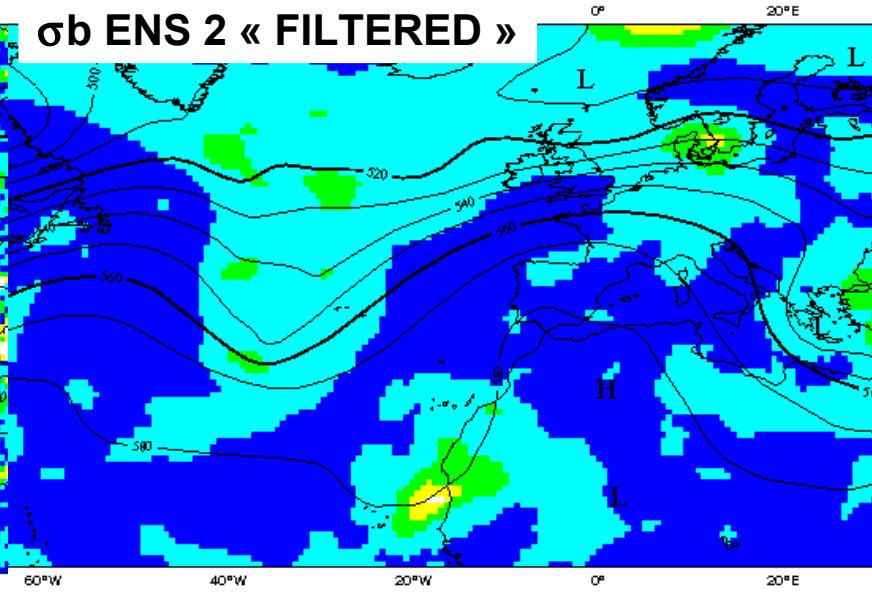
σb ENS 1 « FILTERED »



σb ENS 2 « RAW »

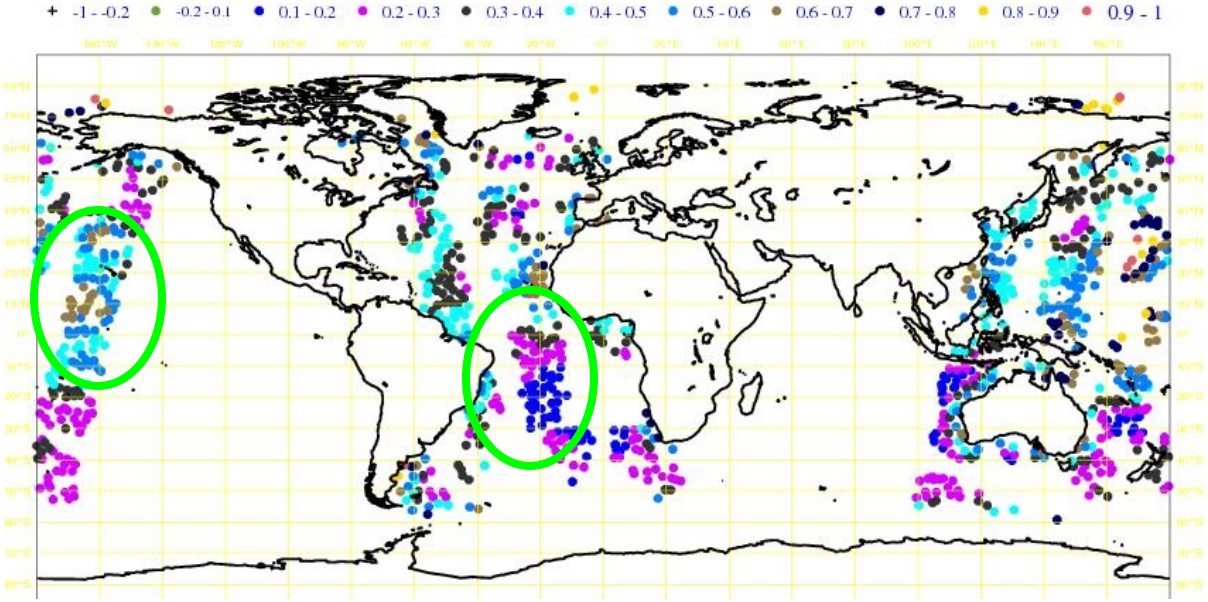


σb ENS 2 « FILTERED »



Validation of ensemble sigmab's
HIRS 7 (28/08/2006 00h)

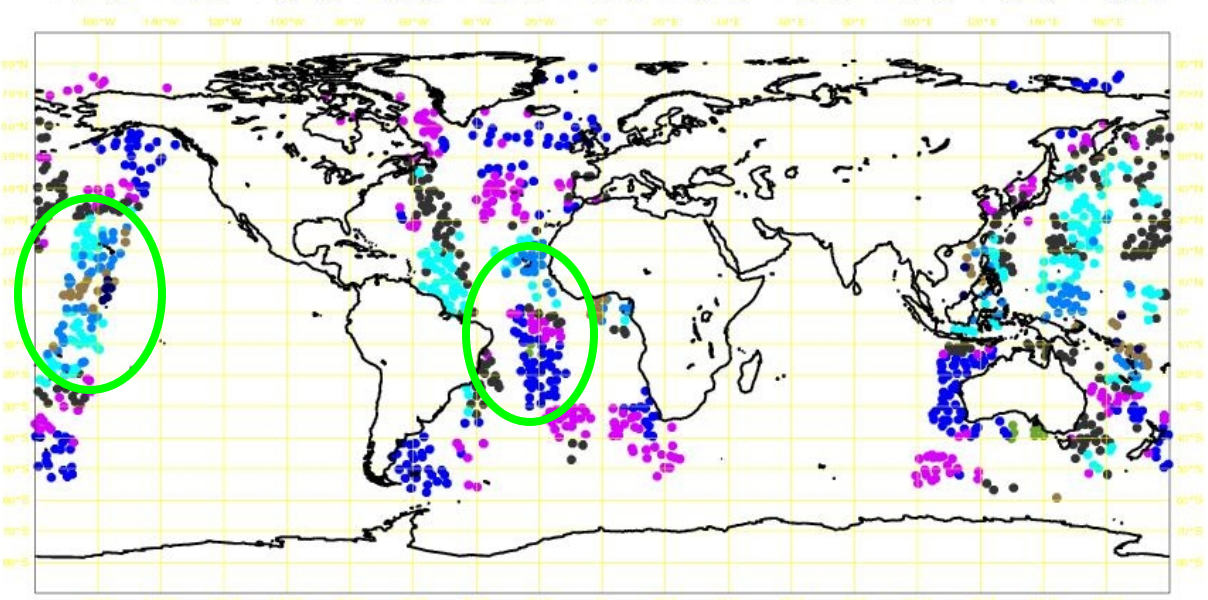
Ensemble sigmab's



« Observed » sigmab's

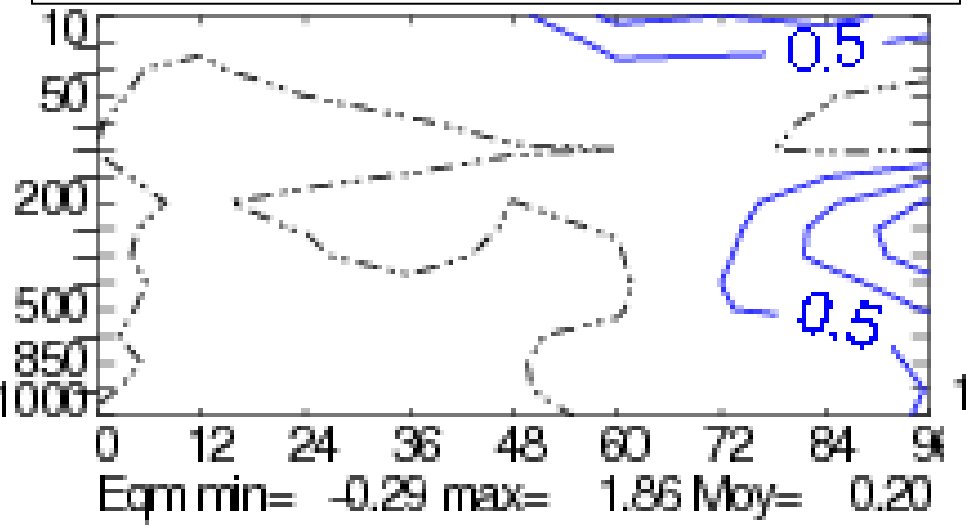
cov(H dx , dy) ~ H B H^T

(Desroziers et al 2005)

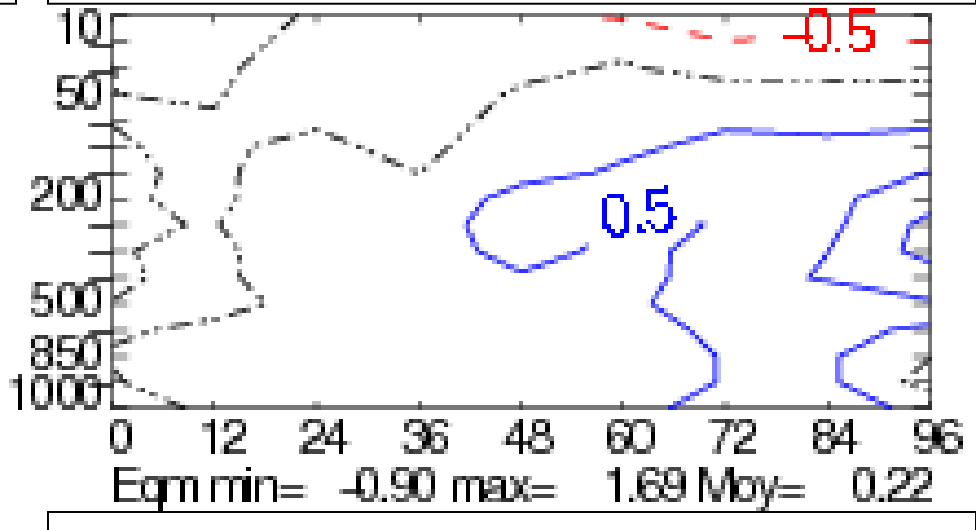


REDUCTION OF NORTHERN AMERICA AVERAGE GEOPOTENTIAL RMSE WHEN USING SIGMAB's OF THE DAY

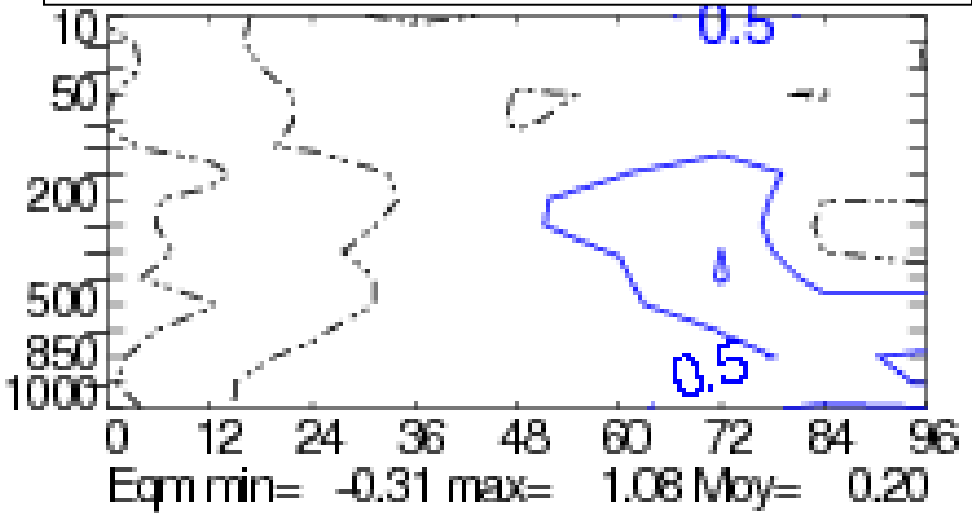
NOV 2006 - JAN 2007 (3 months)



FEB - MARCH 2008 (1 month)

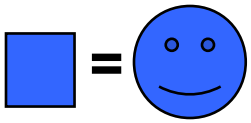


SEPT - OCT 2007 (1 month)



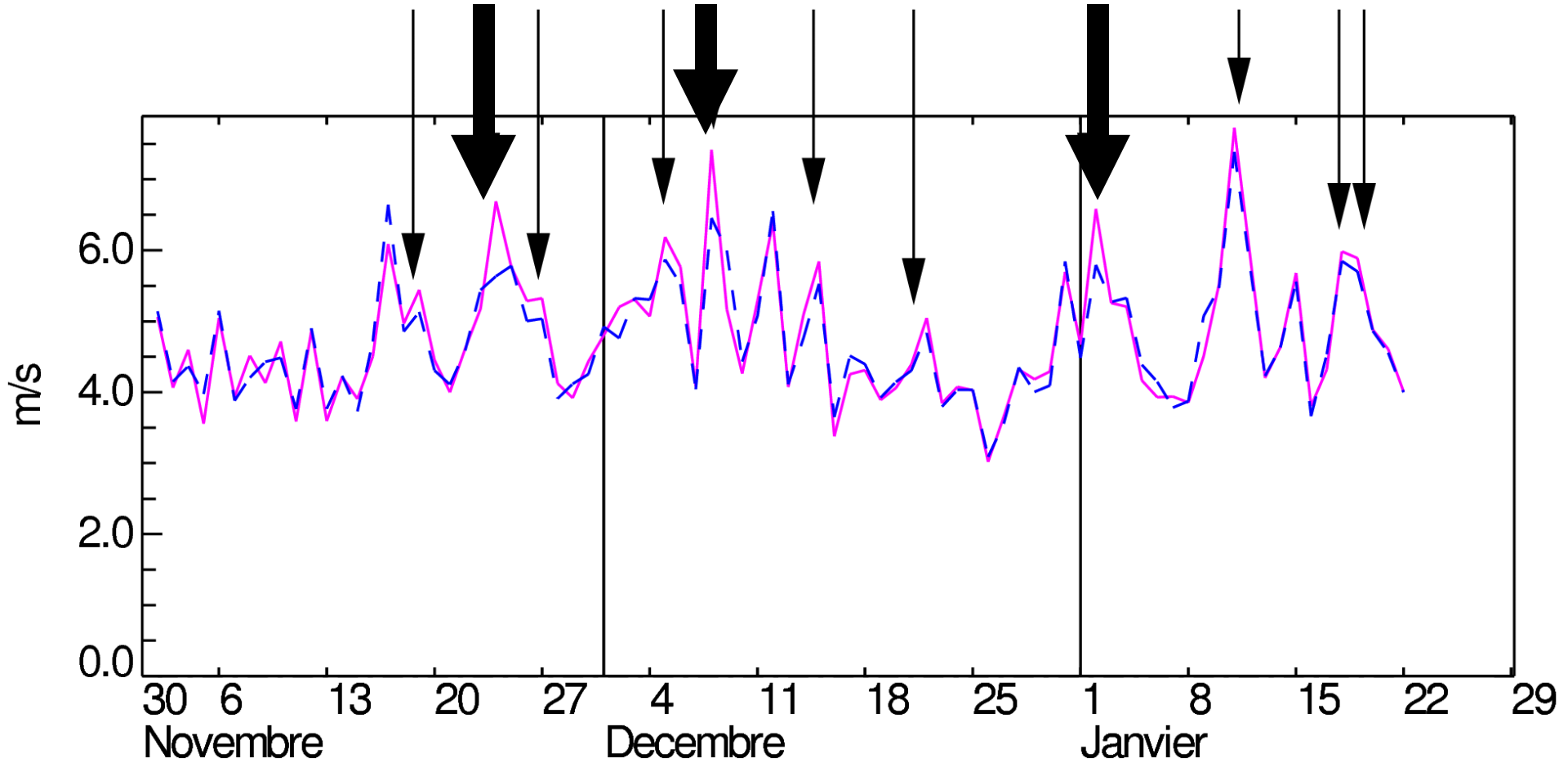
Forecast range (hours)

Height (hPa)



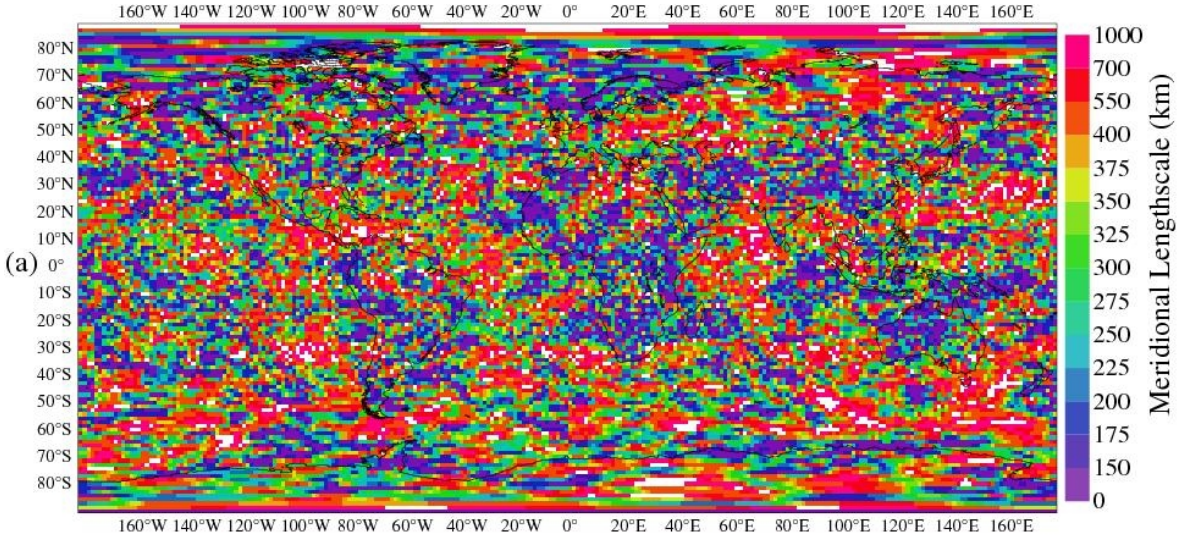
+24h 500 hPa WIND RMSE over EUROPE

(climatological σb's versus σb's of the day)

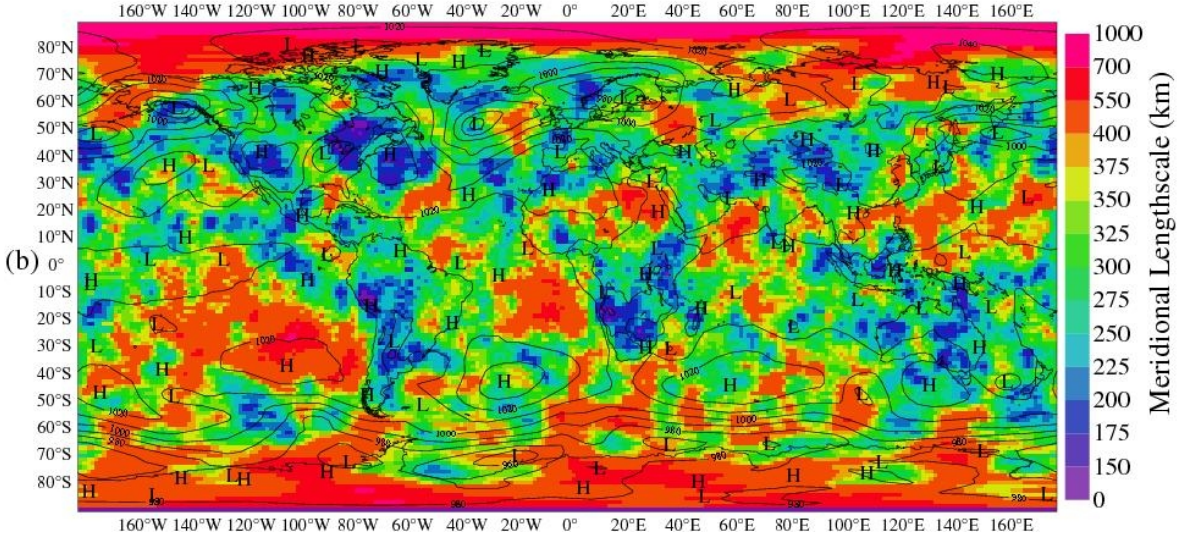


⇒ **Reduction of RMSE peaks (intense weather systems)**

Wavelet filtering of correlations « of the day »



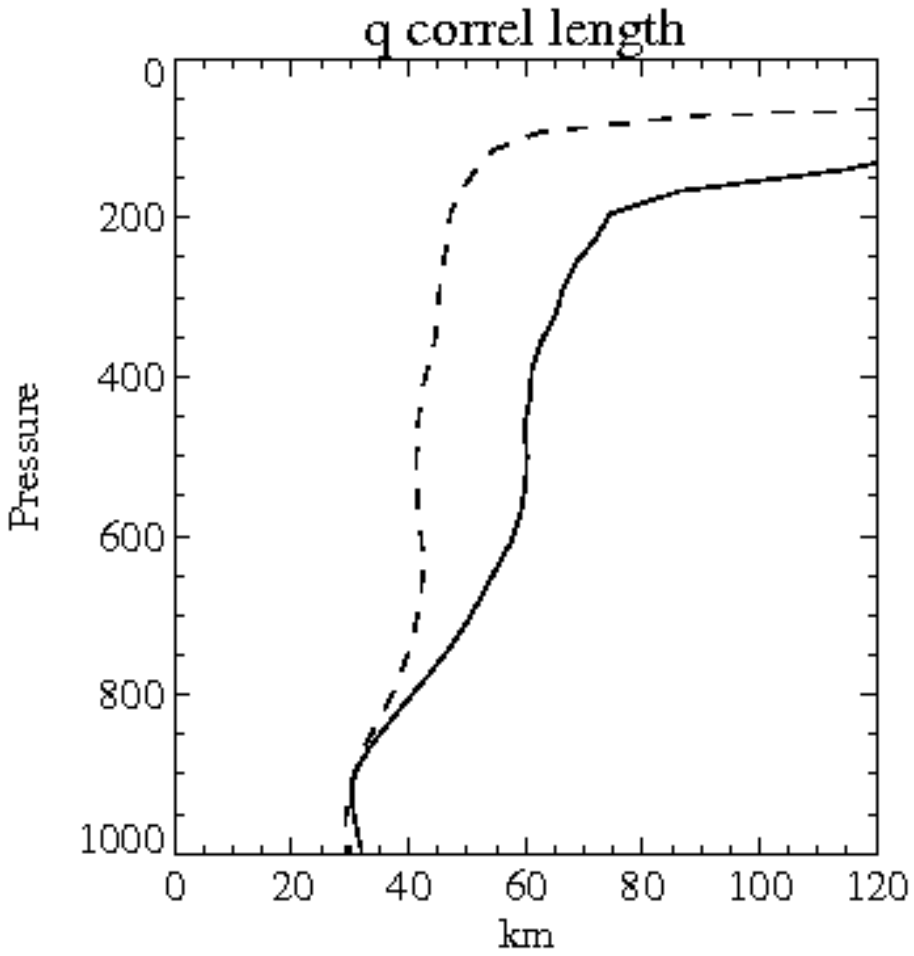
Raw length-scales

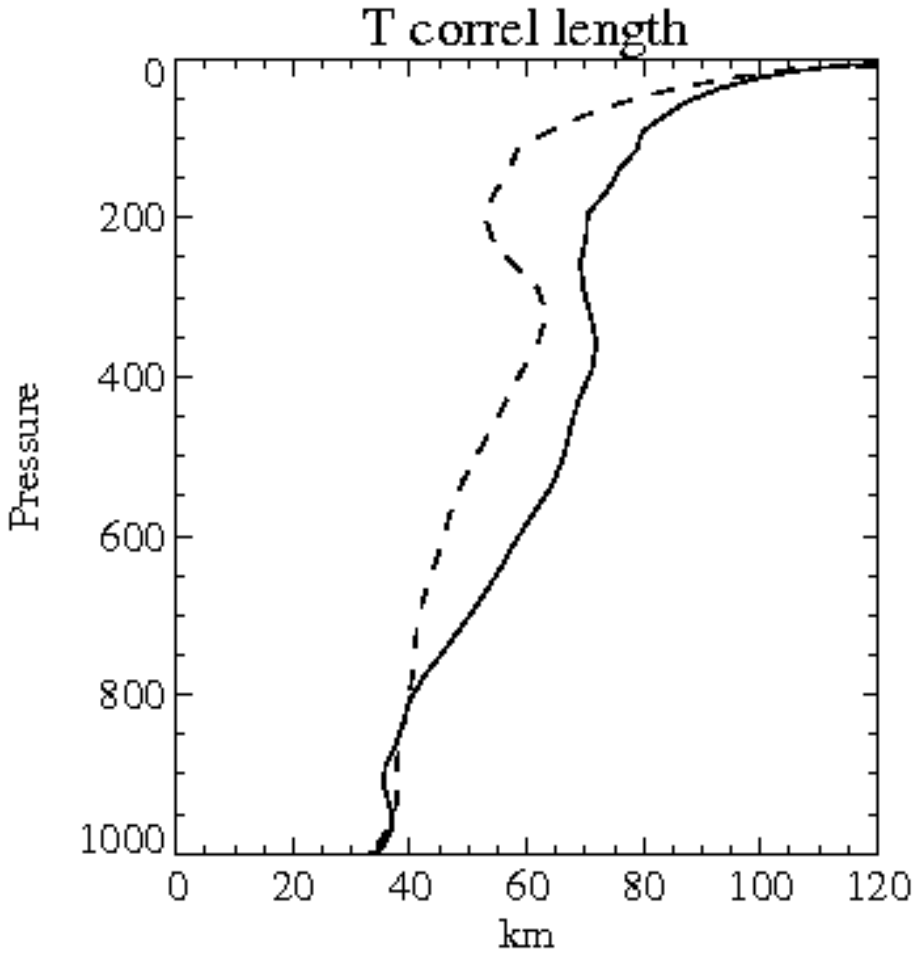


Wavelet length-scales

(Pannekoucke, Berre and Desroziers, 2007 ; Deckmyn and Berre 2005)

LAM ensemble (Arome) : seasonal dependence of correlations



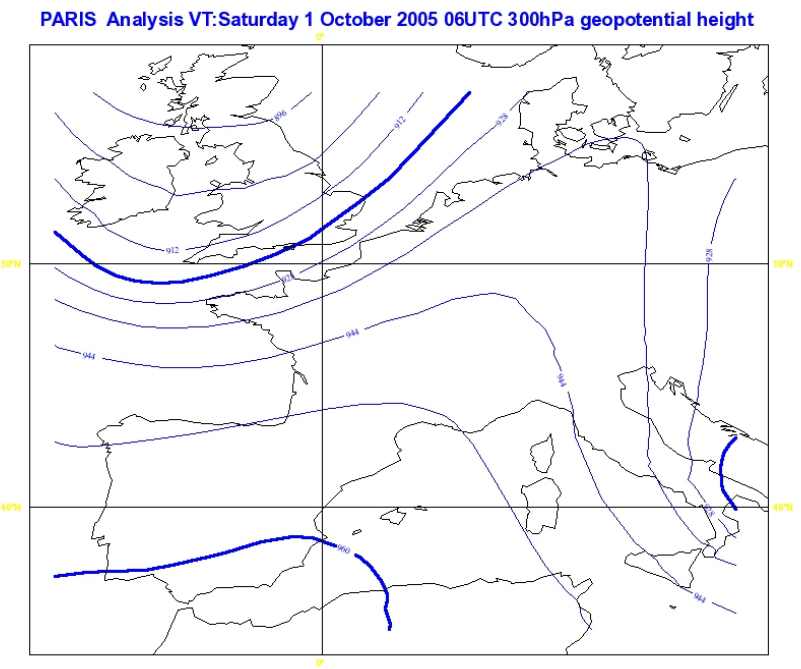


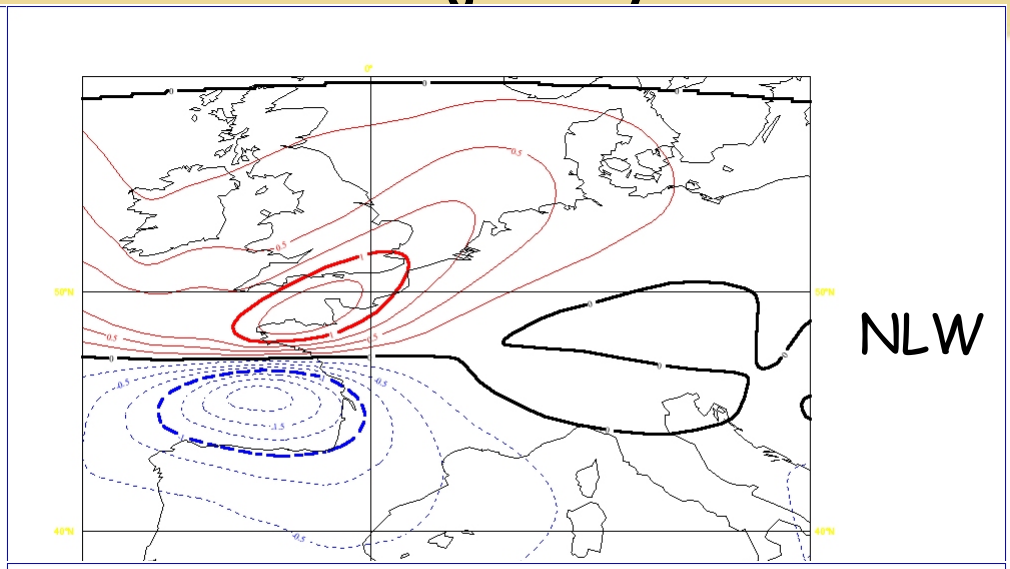
(Desroziers et al, 2007)

_____ **anticyclonic winter**

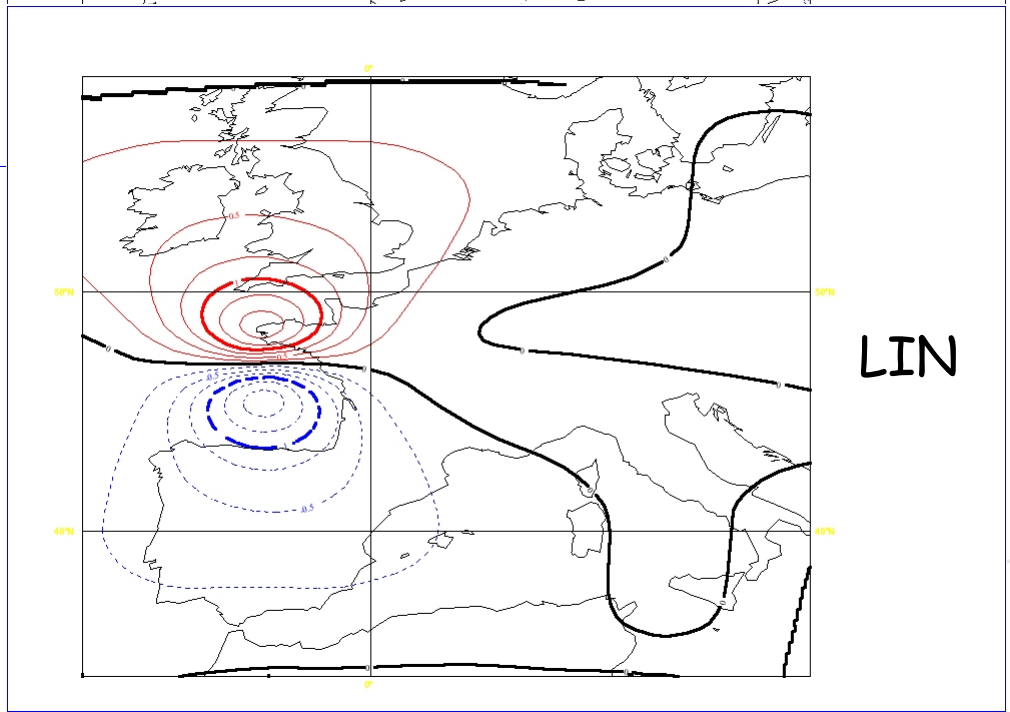
- - - - - convective summer

NON LINEAR & OMEGA BALANCES
Flow-dependent effects of the jet dynamics





NLW



LIN

Fisher (2003) adapted to LAM:
operational in Aladin-France
and in Aladin-Réunion

Studies on RH*

Over-simplified flow-dependence of $\sigma_b(RH_b)$.
ex: lack of local data density effects.

$\Rightarrow$ Wrong horizontal variations of σ_b e.g. at low levels (compared to ensemble).

Spurious reduction of σ_b near zero and near saturation (σ_b ~1% !),
due to assumption that eb=0 in the (1st) minimisation,
while eb is rather unknown at this stage.

$\Rightarrow$ Risk of ignoring useful observed information near 0 and near sat°.

Less problem with negative humidities and supersaturation ?
This can be achieved (more directly) with existing a posterori corrections.

Impact of RH* in Arpège+Aladin: neutral to slightly negative.

- Consider either Per Undén's flow-dependent formula,
  or ensemble, instead of RH*.

Conclusions

- A 6-member assimilation ensemble in real time (double suite).
  ⇒ flow-dependent « sigmab's of the day ».
  ⇒ operational within 2008.

- Spatial filtering of sigmab's strengthens their robustness.
  ⇒ later extension to « correlations of the day » (spectral/wavelet).

- Comparisons with innovation diagnostics and impact experiments are encouraging.

- Applications for assimilation diagnostics and ensemble prediction too: Météo-France EPS will be coupled to the ensemble assimilation.

- Non linear and omega balances are now operational in Aladin-F+R (jet dynamics) ; Undén's formula + ensemble are considered for humidity heterogeneities.

Thank you
for your attention !